Int.J.Curr.Microbiol.App.Sci (2017) *6*(5): 2501-2508

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 5 (2017) pp. 2501-2508**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.605.280

Comparative Potential of Different Plant Products and Synthetic Insecticides and Their Economics against *Cnaphalocrocis medinalis* in Rice

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Keywords

Leaf folder, Plant products, Chlorantran-Ilipole, Cost Benefit ratio, Rice

Article Info

Accepted:
25 April 2017
Available Online:
10 May 2017

A B S T R A C T

The study was conducted to compare the effects of different plant products: Neem oil, NSKE, Karanj oil, Karanj seed powder extract, Chilli garlic solution, Chilli solution and Chlorantraniliprole on leaf folder's population in a rice field at Research cum Instructional Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya Raipur (C.G.) during Kharifseason 2015-16.Yield losses due to leaf folder is estimated 23-30 percent every year (Prakash *et al.,,* 2008). The experiment was laid in randomized block design (RBD) with three replicates. Biological insecticides including six botanical (Neem oil, NSKE, Karanj oil, Karanj seed powder extract, Chilli garlic solution, Chilli solution) and one insecticide (Chlorantraniliprole) were applied to the rice crop. The leaf folder's population was counted one day before and after three, seven and fourteen days from treatment application. Chlorantraniliprole 18.5% SC showed least leaf damage per cent (1.10 mean leaf damage per cent on per five hills). Among different plant products, Karanj oil followed by Chilli garlic solution were found to be most effective treatments with minimum 2.26 and 2.45 mean leaf damage per cent and maximum 41.45 and 36.53 per cent reduction over control respectively. The findings on incremental cost benefit for different treatments revealed that the highest ICBR (1: 5.56) was obtained in the treatment of Chilli solution and it appeared as the most economically viable treatment. The treatment with spraying of Karanj oil was found to be the next profitable treatment providing the ICBR 1:5.32 followed by Neem oil (1:5.05).

Introduction

Asian cultivated rice *Oryza sativa* (2n=24) is the world's most important food crop and is primary source of energy for more than one third of world's population. Rice accounts for 35 to 60 % of the calories consumed by three billions Asian (Khush, 2005). Rice is the staple food for more than 60 per cent of the world's population in which most of the people belong to south-east Asian countries.

Approximately 92% of all rice produced from 90% of global area in Asia (IRRI, 1995). In the world rice has occupied an area of 160.69 million hectares, with a total production of 478 million metric tonnes with productivity of 4.44 metric tonnes/ha in 2014 (USDA, 2015). India, the second largest producer of rice after China has an area of over 439.49 lakh hectares with the production of 106.54 million

tones and productivity 2424 kg/ha in 2014-15 (Indian budget, 2015)

It is the agricultural commodity with the third highest worldwide production, after sugarcane and maize, according to data of FAOSTAT 2012. Its productivity is adversely impacted by numerous biotic and abiotic factors. Among the biotic factors, stem borer, leaf folder, case worm and brown plant hopper are the major constraints in rice productivity and causing huge yield losses every year in rice grown throughout tropical, subtropical and temperate areas in Asia (Park *et al.*, 2008).

Chhattisgarh popularly known as "Rice Bowl of India" occupies an area around 3756.80 thousand hectares with the production of 5.22 million tones and productivity of 2050 kg per hectares (Krishi Dairy, 2016). The productivity of rice in Chhattisgarh is comparatively lower than national average. The prime causes of low productivity of rice in Chhattisgarh are limited irrigation, lack of improved varieties under different ecosystems, several insect pest constraints, inappropriate nutrient and crop management practices.

More than 100 species of insect have been recorded to infest the paddy crop but only about 20 of them are of major economic significance and a few are widely distributed with great potential to create a havoc to paddy crop (Pathak and Khush, 1979). YSB causes 1% to 19% yield loss in early planted and 38% to 80% in late transplanted rice crops. Yield losses due to leaf folder are estimated 20-30 percent every year (Prakash *et al.*,, 2008). Gundhi bug induced loss may range up to 25-35 percent (Baneerjee and Chaterjee, 1982). The yield loss due to hoppers ranges from 10 to 90 percent (Anonymous, 2004). India ranks 10th in the world in pesticides consumption as its total consumption amount to about 500 million tonnes. India is presently the largest manufacturer of basic pesticides among the South Asian and African countries, with an exception of Japan. The Indian pesticides market is the 12th largest in the world with a value of US$0.6 billion. Manufacturers and researchers are designing new formulations of pesticides to meet the global demand. Ideally, the applied pesticides should only be toxic to the target organisms, should be biodegradable and eco-friendly to some extent. Unfortunately, this is rarely the case as most of the pesticides are non-specific and may kill the organisms that are harmless or useful to the ecosystem. In general, it has been estimated that only about 0.1% of the pesticides reach the target organisms and the remaining bulk contaminates the surrounding environment (Carriger *et al.*, 2006).

In recent years the use of synthetic insecticides in crop protection programmes around the world has resulted in disturbance of the environment, pest resurgences, pest resistance to pesticides and lethal effect to non-target organisms in the agro-ecosystems in addition to direct toxicity to users. Therefore, it has now become necessary to search for the alternative means of pest control, which can minimize the use of synthetic pesticides.

Botanical pesticides are the important alternatives to minimize or replace the use of synthetic pesticides as they possess an array of properties including toxicity to the pest, repellency, anti-feedance, insect growth regulatory activities against pests of agricultural importance. In fact, botanical pesticides are in use in Indian agriculture for over a century to minimize losses caused by pests and diseases (Prakash *et al.*, 1997). Botanical pesticides have many advantages over synthetic pesticides like: in general it possess low mammalian toxicity thus constitute least or no health hazards and environmental pollution, There is practically

no risk of developing pest resistance to these products when used in natural forms, These causes less damage to non-target organisms and pest resistance has not been reported except synthetic pyrethroids. No adverse effects on plant growth, seed viability and cooking quality of the grains and botanical pesticides are less expensive and easily available because of their natural occurrence.

Looking to the above mentioned facts, it is imperative to evolve and evaluate some useful plant products for management of pest, so that quantity of insecticides used to control the insects can be reduced. Hence, these useful practices could be utilized as the major components of an effective pest management strategy, against major insect pests of rice.

Materials and Methods

Geographical Location

Raipur is situated in mid-eastern part of Chhattisgarh and lies between 21.160 North latitude and 81.630 East longitude with altitude of 298.15 meter above the mean sea level. This state has three different agro climatic zones viz. Chhattisgarh plain, Bastar plateau and Northern hill region.

Weather and Climate

The climate of Raipur is characterized as sub-humid with normal rainfall of 1200-1400 mm per annum, out of which about 85 per cent is received from third week of June to mid-September and very little during October to February.

May is the hottest (46°C) and December is the coolest (6°C) month of the year. The pattern of rainfall, particularly during June to September months has great variation from year to year, with occasional light showers during winter and summer season.

The average maximum and minimum temperature found 42.8°C and 10.1°C during month of May and December, respectively.

To evaluate the efficacy of different plant products against leaf folder

To determine the bio- efficacy of different plant products against leaf folder in rice crop, field experiment was conducted under randomized block design (RBD) with eight treatments and three replications. Pretreatment observation was recorded a day before the botanical application, while post treatment observations were under taken after 3, 7 and 14 days of spraying.

The variety Swarna was transplanted in plot size of 5X 4 m² with a spacing of 20 X15 cm2 as per normal recommended agronomical practices. The Knapsack sprayer and spray volume @ 500 l/ha used with hollow cone nozzle to impose the uniform spray of plant products in each treatment application.

Leaf Damage counting and Statistical Analysis of the Data

Observations were recorded by counting number of healthy and damaged leaves on 5 randomly selected hills from each plot one day before application of treatments as pre-treatment observation followed by 3,7 and 14 days after treatment application as post treatment observations.

The per cent incidence of leaf folder was computed by using following formula:

$$\text{Per cent Incidence} = \frac{\text{Number of damaged leaves}}{\text{Total number of leaves}} \times 100$$

Standard statistical procedure was followed as per Gomez and Gomez (1984) the student's t

test and contrast test were used for ANOVA and mean comparison respectively.

To study the relative economics of different plant products against recommended insecticidal management

Experiment was conducted in randomized block design at the Research cum Instructional arm, College of Agriculture, IGKV, Raipur during Kharif2015-16 with eight treatments including an untreated control. The seedlings were transplanted in the main field on 18thAugust, 2015. The first spraying of each treatment commenced from 45 days after transplanting and further, it was repeated at 25 days interval. In order to compare the response of different treatments on grain yield, the harvesting of grain was done and the yield obtained in the net plot of each treatment was recorded.

The data on yield of grains were used to calculate the economic viability of each treatment. The cost of treatments, spray material and labors required for application was calculated as per prevailing rates. Similarly the income obtained from the sale of grains as per market rate was also calculated for each treatment. The data, thus obtained were used to calculate the monetary returns and incremental cost benefit ratio.

Results and Discussion

Efficacy of each plant product was determined in terms of their capacity to suppress the percentage of leaf damage by leaf folder in comparison to 'control' plots. Highest percent reduction over control (PROC) was recorded in insecticidal treated plot i.e. T7 (72.06%).Among different plant products, highest percent reduction over control (PROC) was recorded in Karanj oil (41.45%), Chilli garlic solution (36.53%), Neem oil (24.35%), Chilli solution (23.83%), Karanj seed powder extract (23.57%) and NSKE (10.36%) in descending order (Table 2). The present findings are in confirmation with the findings of Dhaka *et al.,* (2011), they evaluated efficacy of insecticides, bio-pesticides and botanicals against rice leaf folder, *Cnaphalocrocis medinalis*. All the botanicals were found effective in managing leaf folder and increased grain yield over control. Fipronil 5 SC was found to be best as compared to others as it was also found economical, followed by Karanj oil and NSKE respectively.

The highest grain yield of paddy (59.56 q/ha) was obtained in the plot treated insecticides (Chlorantraniliprole 18.5% SC). It was statistically the most significant and superior to any of the plant product treatments. Among different plant products, highest yield of grains was obtained in the treatment of Karanj oil (54.78 q/ha) followed by Karanj seed powder extract (53.35 q/ha), Neem oil (53.32q/ha) and NSKE (52.74 q/ha) all were statistically at par with each other. The treatments of Chilli garlic solution and Chillisolution recorded grain yield of 49.86 and 50.83 q/ha respectively and these two treatments were also found to be statistically equal in effectiveness.

In terms of investments in crop production, as the labour and spraying charges were similar in each treatments and hence application cost of insecticides were taken into account for comparison, the highest cost (Rs.7460) was incurred in the treatment NSKE 5% followed by insecticide (Chlorantraniliprole 18.5% SC (Rs.5310), Karanj seed powder extract (Rs.5060). The lowest cost of treatment was found in Chilli garlic solution and Chilli solution (Rs.2460) followed by Neem oil (Rs.3260) and Karanj oil (Rs.3460). However, irrespective of the treatment cost, the yield recorded was maximum in insecticide treatment 54.78 q/ha followed by Karanj oil

(54.78 q/ha), Karanj seed powder extract (53.35 q/ha), Neem oil (53.32 q/ha) and NSKE (52.74 q/ha). The lowest yield was recorded in Chilli garlic solution (49.85 q/ha). Net monetary return was highest when crop was protected with two sprays of insecticide (Chlorantraniliprole 18.5% SC) (Rs.28797) followed by Karanj oil (Rs. 21866), Karanj seed powder extract (Rs.19792), Neem oil (Rs.19749), NSKE (Rs.18908), Chilli solution (Rs. 16138) and Chilli garlic solution (Rs. 14717). The findings on incremental cost benefit for different treatments (table 4.7) revealed that the highest ICBR (1: 5.56) was obtained in the treatment of Chilli solution and it appeared as the most economically viable treatment. This might be due to relatively less cost of expenditure (Rs.2460). The treatment with spraying of Karanj oil was found to be the next profitable treatment providing the ICBR 1:5.32followed by Neem oil (1:5.05) (Table 3).

Table.1 List of botanicals with dose used in experiment

Treatment	Botanicals	Dose	Quantity per hectare
T_1	Neem oil + Teepol @ 1ml/l	2%	10 litres/ha
T_2	NSKE (neem seed kernel extract)	5%	25 litres/ha
T_3	Karanj oil + Teepol @ 1ml/l	2%	10 litres/ha
T_5	Chilli- garlic solution + kerosene oil @ 2ml/l + surf10gm	9.5 kg/ha	9.5 kg/ha
T_6	Chilli solution + kerosene oil @ 2ml/l + surf 10 gm	10 kg/ha	10 kg/ha
T_7	Chlorantraniliprole 18.5 SC	0.3 ml/litre water	150 ml insecticide/ha
T_8	Untreated control (Plain water supply)		500 litres water

Table.2 Relative bio-efficacy of different plant products against leaf folder infestation

Mean leaf damage per cent caused by leaf folder on per 5 hills											
		1st spraying				2nd spraying				Overall	
S. No.	Treatments	Pre	3DAS	7DAS	14DAS	Pre	3DAS	7DAS	14DAS	Mean	PROC%
T1	Neem oil	4.83 (12.58)	2.35 (8.70)	2.82 (9.63)	4.83 (12.58)	0.97 (5.32)	3.11 (8.43)	2.09 (8.17)	2.33 (8.57)	2.92 (9.25)	24.35
T2	NSKE	4.66 (12.42)	4.74 (12.48)	4.01 (11.1)	3.66 (10.89)	1.42 (6.69)	3.56 (9.99)	3.23 (9.12)	2.42 (8.11)	3.46 (10.1)	10.36
T3	Karanj oil	4.48 (12.10)	2.77 (9.54)	2.02 (8.00)	3.86 (11.28)	1.04 (5.61)	1.01 (5.70)	1.67 (7.41)	1.20 (6.09)	2.26 (8.22)	41.45
T4	Karanj seed powder	4.03 (11.45)	3.65 (10.98)	4.03 (11.4)	4.41 (12.05)	0.92 (4.39)	1.7 (7.35)	2.54 (8.98)	2.34 (8.78)	2.95 (9.42)	23.57
T5	Chilli garlic solution	4.31 (11.87)	2.22 (8.29)	2.59 (9.20)	3.30 (10.33)	0.69 (3.78)	1.08 (1.35)	3.45 (10.7)	1.93 (7.92)	2.45 (7.93)	36.53
T6	Chilli solution	5.32 (13.19)	3.14 (8.35)	3.23 (9.12)	4.56 (12.17)	0.92 (5.54)	1.35 (6.61)	2.95 (9.01)	2.04 (8.20)	.2.94 (9.02)	23.83
T7	Chlorantranilipr ole	4.08 (11.61)	1.25 (5.24)	0.34 (1.93)	0.34 (1.93)	1.12 (4.96)	1.02 (5.60)	0.38 (2.89)	0.23 (2.24)	1.10 (4.55)	72.06
T8	Control	4.15 (11.68)	4.81 (12.59)	4.08 (11.6)	4.15 (11.6)	1.06 (5.83)	4.15 (11.6)	4.31 (11.9)	4.16 (11.61)	3.86 (11.05)	
	SE	1.101	1.61	1.24	1.39	1.54	1.23	1.19	1.01		
	CD	NS	4.321	3.81	4.25	NS	3.98	3.66	3.09		

Figures in parentheses are Arc-sine transformed values, DAS = days after spraying, NS = Non significant, PROC = per cent reduction over control

Table.3 Relative economics of different plant product treatments during the study (*Kharif*, 2015)

S. No.	Treatments	Qty. of treatment materials(per ha)	No. of spray	Cost of treatments	Labour + sprayer Charges	Total cost A	Yield q/ha	Increased yield over control q/ha	Value of increased yield q/ha B	Increment Benefit C (B-A)	ICBR C/A
1	Neem oil 2%	10 l/ha	2	2800	460	3260	53.32	13.62	19749	16489	1:5.05
2	NSKE 5%	25 kg/ha	2	7000	460	7460	52.74	13.04	18908	11448	1:1.53
3	Karanj oil 2%	10 l/ha	2	3000	460	3460	54.78	15.08	21866	18406	1:5.32
4	Karanj seed powder extract	30 kg/ha	2	4600	460	5060	53.35	13.65	19792	14732	1:2.91
5	Chilli garlic solution	9.5 kg/ha	2	2000	460	2460	49.85	10.15	14717	12257	1:4.98
6	Chilli solution	10 kg/ha	2	2000	460	2460	50.83	11.13	16138	13678	1:5.56
7	Triazophos 40% EC Chlorantraniliprole 18.5% SC	150 ml/ha	2	4880	460	5310	59.56	19.86	28797	23487	1:4.42
8	Untreated control						39.70				
	SE	0.786									
	CD @ 5%	2.38									

Labour charges: Rs. 200 per day
Spray pump charges: Rs. 30 per day
Minimum support price of paddy: Rs. 1450

In conclusion, the use of chemical pesticides causes significant reduction in the population of natural enemies of pests. This may reduce the efficiency of biological control of insect-pest in rice field and can cause severe outbreak. The plant products are less harmful and can be used in rice field for pest management without causing adverse effects on natural enemies and environment. The use of inexpensive botanical insecticide will also encourage agroforestry at farm level.

Acknowledgement

The author expresses her heartfelt gratitude to Dr. V.K. Dubey, Scientist and Head Department of Entomology, Dr. Y.K. Yadu Scientist Department of Entomology and Dr. R.R. Saxena, Professor Department of Agricultural Statistics and Social Science, I.G.K.V. Raipur (C.G.) India for their excellent guidance, suggestions and regular encouragement during the course of investigation.

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How to cite this article:

Niyati Pandey and Rupesh Kumar Gajbhiye. 2017. Comparative Potential of Different Plant Products and Synthetic Insecticides and Their Economics against *Cnaphalocrocis medinalis* in Rice. *Int.J.Curr.Microbiol.App.Sci.* 6(5): 2501-2508.
doi: https://doi.org/10.20546/ijcmas.2017.605.280